

REMARKS

Claims 1-9 are pending in the application. Claims 10-16 have been withdrawn by the Examiner. Applicant has amended claims 1-5 to recite a method for crystallization or dopant activation heat treatment of a semiconductor film, and has amended claims 6-9 to recite an apparatus for crystallization or dopant activation heat treatment of a semiconductor film. This amendment is made solely for the purpose of clarifying the scope of the claims and assisting the Examiner in identifying the differences between the cited art and the claim. Applicant expressly notes that therefore this amendment is not made for purposes related to patentability, because the amendment does not alter the scope of the claim, but rather merely clarifies it. Claims 1-9 have further been amended to correct various grammatical and typographical errors.

Objections to the Drawings

The drawings stand objected to because Fig. 3 shows element 320, which is not discussed in the specification. The specification has been amended herein to refer to element number 320, and Applicant submits that this objection has been obviated and requests that it be withdrawn.

Objections to the Specification

The abstract stands objected to because it includes the phrase "the invention relates to." The abstract has been cancelled and a new abstract is presented herein that parallels the language of amended claim 1 and that no longer includes this phrase. Applicant submits that this objection has also been obviated and should be withdrawn.

Objections to the Claims

Claims 1-9 stand objected to because they refer to multiple films and substrates. Claims 1-9 have been amended herein and they now refer to a single film and a single substrate. Claim 7 further stands objected to for lacking antecedent basis for the element "the glass substrate." Claim 7 has been amended to recite "said substrate" instead of "the glass substrate." Applicant thus requests that this objection also be withdrawn.

Rejection under 35 U.S.C §103

Claims 1-7 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Pat. No. 5,669,975 to Ashtiani in view of U.S. Pat. No. 5,970,368 to Sasaki et al. In particular, the Examiner finds that Ashtiani discloses an apparatus for processing at least a surface of an article with uniform plasma comprising installing induction coil (30) in close proximity to semiconductor film on substrate (62) lying on a susceptor (68), wherein the winding configuration of said induction coil (30) is set in such a way that the current direction of the inductor is parallel to the in-plane direction of said semiconductor film. The Examiner further found that Ashtiani does not disclose using a nonconducting substrate, but that Sasaki et al. disclose a method for manufacturing polycrystal semiconductor film having a nonconducting substrate at column 1, lines 13-16. Thus, the Examiner opines that it would have been obvious to one having ordinary skill in the art to use Ashtiani with a nonconducting substrate as taught by Sasaki to prevent the substrate from being heated by an alternating magnetic field.

Applicant respectfully traverses the Examiner's rejection. The amended claims are directed to a method and apparatus for crystallization or dopant activation heat treatment of a semiconductor film upon a thermally susceptible non-conducting substrate. In accordance with the claims, a semiconductor film in an amorphous state can be crystallized into polycrystalline, and a semiconductor film in a polycrystalline state implanted with dopants can be electrically activated, without causing damage to or distortion of the thermally susceptible non-conducting substrate, which may be a glass or plastic substrate. This can be achieved by selective joule heating of the semiconductor film such as a silicon film or the movement activation of atoms by EMF, as disclosed at page 8 of the specification. To selectively heat only the semiconductor film, the induction coil must be disposed so that the electrical current direction is aligned parallel to the in-plane direction of said semiconductor and thus the direction of the magnetic field generated by the current flowing through the coil is perpendicular to the plane of the film and the semiconductor film can be heated by the susceptor to the extent that the semiconductor film can be induction-heated. Under these conditions, crystallization heat treatment or dopant activation heat treatment can be carried out solely on the semiconductor film without negatively affecting the non-conducting substrate.

The cited art neither discloses nor suggests the claimed invention. Prior to a detailed discussion of the art, it is necessary to note that a semiconductor wafer such as a silicon wafer does not include a thermally susceptible non-conducting substrate such as a glass or a plastic substrate. For this reason, a semiconductor wafer can be heat-treated at very high temperatures at which the thermally susceptible non-conducting substrate of the present invention is readily distorted. The Examiner refers to Ashtiani, Daviet, Suzuki, and Arima as relating to the treatment of semiconductor wafer. Of the art cited by the Examiner, only Sasaki discloses a semiconductor film formed on a thermally susceptible non-conducting substrate. A semiconductor film on a non-conducting substrate has been well known to be difficult to heat-treat and a pulse laser annealing process as disclosed by Sasaki is one of the known processes for achieving this, as described in the specification of the present application.

Ashtiani discloses an apparatus and process for providing improved uniformity of high density plasma over a semiconductor wafer, which is useful in a sputter etching apparatus. Ashtiani teaches using an induction coil to increase the ionization degree of a source gas in a plasma, thereby improving the density of reactive ions bombarding the semiconductor wafer, and specifies a very specific shape for the induction coil such that "the electric fields generated thereby tend to cancel each other out." (col. 5, lines 22-23) Therefore, Ashtiani is non-analogous art and one skilled in the art would not look to Ashtiani when performing crystallization or dopant activation heat treatment of a semiconductor film.

Similarly, Sasaki discloses a method for manufacturing a polycrystal semiconductor film by applying a high energy beam to a surface of the semiconductor film. More specifically, the irradiation of the high energy beam (e.g. a laser) creates a local melting zone in the semiconductor film, and an alternating current field from an induction coil allows the local melting zone to be prolonged until the completion of the solidification of the semiconductor film so as to control the size of crystal grains, by compensating for heat dissipation from local heating zone to substrate. Accordingly, while this method comprises prolonging the solidification time of the local melting zone, Applicant's claimed process comprises crystallizing a semiconductor film, which is in the solid state. Thus, Sasaki is also non-analogous art. Furthermore, there is no motivation whatsoever in either Sasaki or Ashtiani to combine the two references nor to apply their teachings to the problem of crystallization or dopant activation heat treatment of a

semiconductor film. Applicant thus submits that the rejection is improper and respectfully requests that the Examiner withdraw it.

Claims 1-8 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Pat. No. 6,056,848 to Daviet in view of U.S. Pat. No. 5,578,521 to Suzuki et al. In particular, the Examiner finds that Daviet discloses a plasma reactor and methods for processing a semiconductor substrate comprising installing induction coil (106) in close proximity to semiconductor film on substrate (104) lying on a susceptor (118), wherein the winding configuration of said induction coil (106) is set in such a way that the current direction of the inductor is parallel to the in-plane direction of said semiconductor film. The Examiner further found that Daviet does not disclose using a nonconducting substrate, but that Suzuki et al. disclose a nonconducting substrate (12) placed on a quartz tray (13) supported on graphite susceptor (14). Thus, the Examiner opines that it would have been obvious to one having ordinary skill in the art to use Daviet with a nonconducting substrate as taught by Sasaki to prevent the substrate from being heated by an alternating magnetic field.

Applicant respectfully traverses this rejection, because Suzuki does not in fact disclose a nonconducting substrate, but rather a semiconductor substrate (12) which is not a nonconducting substrate, as recited in the pending claims. Applicant respectfully reminds the Examiner of the requirements posited by MPEP 2143.03 that “[t]o establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). All words in a claim must be considered in judging the patentability of that claim against the prior art. *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970).” (emphasis added)

Furthermore, Daviet discloses an apparatus and method of providing a thin film electrostatic shield for an inductively coupled plasma source for use in plasma processing, similar to Ashtiani. Daviet is therefore also non-analogous art and is improperly combined with Suzuki because there is no motivation for one skilled in the art to combine the two references nor to apply their teachings to the problem of crystallization or dopant activation heat treatment of a semiconductor film. Applicant thus submits that this rejection is also improper and respectfully requests the Examiner to withdraw it.

Claims 8 and 9 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Pat. No. 6,056,848 to Daviet in view of U.S. Pat. No. 5,578,521 to Suzuki et al. Claims 8 and 9 depend from claim 6. "If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious." *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). Therefore, in light of the above discussion of claim 6, Applicant submits that claims 8 and 9 are also allowable.

In view of the above, Applicants submit that the application is now in condition for allowance and respectfully urge the Examiner to pass this case to issue.

The Commissioner is authorized to charge any additional fees which may be required or credit overpayment to deposit account no. 12-0415. In particular, if this response is not timely filed, the Commissioner is authorized to treat this response as including a petition to extend the time period pursuant to 37 CFR 1.136(a) requesting an extension of time of the number of months necessary to make this response timely filed and the petition fee due in connection therewith may be charged to deposit account no. 12-0415.

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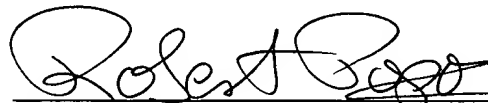


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Respectfully submitted,



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